Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

May 10, 2014

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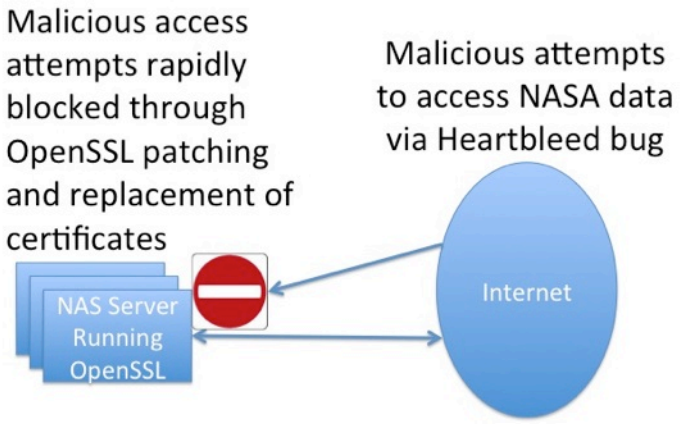
HECC Quickly Mitigates Vulnerabilities Due to Heartbleed Bug

- One of the most serious Internet bugs of all time, Heartbleed, was announced on April 7 as a significant flaw in a widely used OpenSSL encryption code. The bug allowed malicious agents to gain access to encrypted information sent over the network.
- To mitigate the Heartbleed risk, HECC system administrators quickly performed security patching on vulnerable versions of OpenSSL for systems within the HECC/NAS enclave:
  - 35 public-facing servers patched by April 8
  - 17 cloud machines patched by April 8
  - 850 compute nodes patched by April 10
  - 94 internal servers/workstations patched by April 11
- Mitigation also required ordering and replacing authentication certificates for various vulnerable systems. Replacements were completed on April 10, 11, and 14, with the final certificate replaced on April 18 because of the associated system's high availability requirement and minimal risk of outside exposure.

Mission Impact: HECC's ability to respond rapidly to very serious bugs and malware attacks significantly lessens the vulnerability of NASA data transmitted and stored on the agency's advanced computing resources.



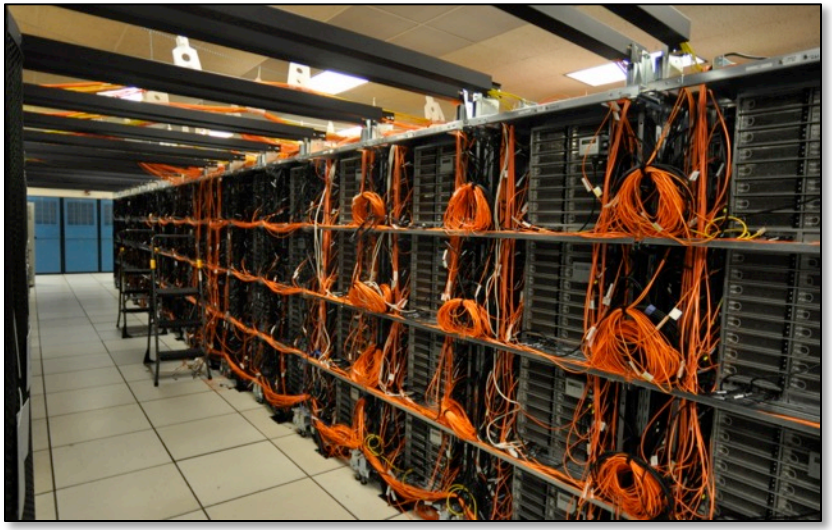
Quick response by HECC system administrators to the very significant Heartbleed bug mitigated the ability of malicious agents to gain access to NASA data.

POC: Thomas H. Hinke, thomas.h.hinke@nasa.gov, (650) 604-3662, NASA Advanced Supercomputing Division

Pleiades InfiniBand Network Maintenance Activities Completed Ahead of Schedule

- To improve the reliability and functionality of the Pleiades supercomputer, HECC systems engineers worked with SGI counterparts to perform maintenance activities on the InfiniBand (IB) network during a scheduled downtime.
- The teams upgraded the firmware on more than 1600 FDR (fourteen data rate) IB switches and 7200 Pleiades nodes to bring the fabric up to date and provide bug fixes and enhanced features.
- The engineers also replaced over 220 IB cables to resolve issues and improve the operation of the IB fabric.
- The teams completed the planned activities ahead of schedule, and the system was released back into production in just 17 hours—well under the 24 hours allotted for the project.

Mission Impact: Maintaining the stability of the HECC InfiniBand network is essential for providing reliable high-performance computing resources to researchers across all NASA mission directorates.



The Pleiades supercomputer is the largest InfiniBand (IB) cluster in the world, with over 65 miles of IB cabling.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing (NAS) Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NAS Division, Computer Science Corp.

HECC Facilities Team Completes Semi-Annual Maintenance on RUPS System

- HECC facilities engineers completed semi-annual maintenance activities for the 6-megawatt (MW) rotary uninterruptible power supply (RUPS) system that provides critical backup power capability for the NASA Advanced Supercomputing (NAS) facility.
- The HECC Facilities team, working with RUPS engineers, completed numerous activities including:
  - Upgraded the control software
  - Identified the cause of high-temperature and vibration alarms
  - Greased the inner and outer bearings
  - Performed general system checks
- To minimize impact to HECC users and NAS facility staff, the work was performed during off hours, over the course of three weekend days.
- The teams ensured that backup power was retained for critical HECC resources by working on just one of the RUPS system's three units each day, leaving two units online at all times.
- The Facilities team will continue to work with RUPS engineers to maintain the highly complex system and ensure that it functions properly.

Mission Impact: Periodic maintenance safeguards the backup power capability for NASA's primary supercomputing facility, providing a more stable computing environment by helping ensure that HECC resources will remain operational in the event of an electrical outage.

Photo of the rotary uninterruptible power supply system supporting the NAS facility at NASA Ames Research Center. The 6-megawatt (MW) system is comprised of three systems supplying 2 MW of power each, and operates at a 14-kilovolt output customized for the NAS facility.

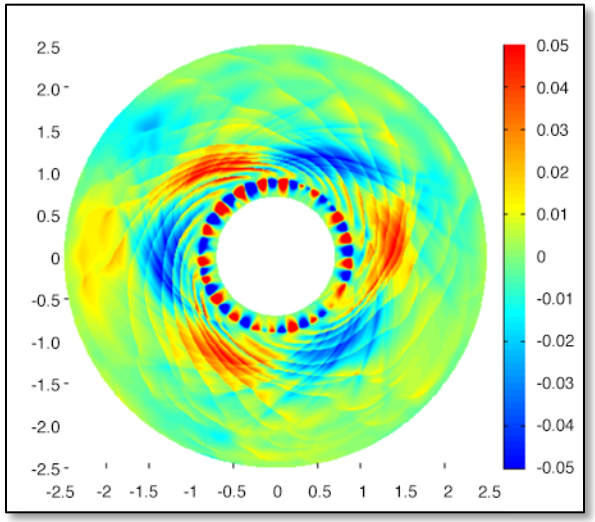
POC: Mark Tangney, mark.l.tangney@nasa.gov, (650) 604-4415, NASA Advanced Supercomputing Division

Pleiades 'Instrumental' to Discovery of New Astrophysical Boundary Layer Instability *

- Accretion is the process by which matter around massive astrophysical objects, such as neutron stars and protoplanets, flows radially toward the central body and forms a disk and boundary layer.
- Researchers at Princeton University performed simulations on Pleiades to investigate the physical mechanisms that drive accretion of material through the boundary layer. Results provide new insights into boundary layer accretion phenomena, including:
  - A new acoustic instability discovered in the boundary layer facilitates angular momentum transport and mass accretion via waves excited at a co-rotation resonance.
  - The new instability excites modes that have a well-defined frequency, which could be linked to periodic variability associated with the boundary layer.
  - Assuming an effective anomalous viscosity in the boundary layer is inadequate when angular momentum is transported by waves, which has ramifications for spectral models and boundary layer structure.
- The complex, 3D magnetohydrodynamic simulations required more than 7 million processor hours on Pleiades, deemed by researchers as "instrumental to our success."

** HECC provided supercomputing resources and services in support of this work*

Mission Impact: The Pleiades supercomputer was crucial to the discovery of an acoustic instability that plays a key role in boundary layer accretion phenomena.



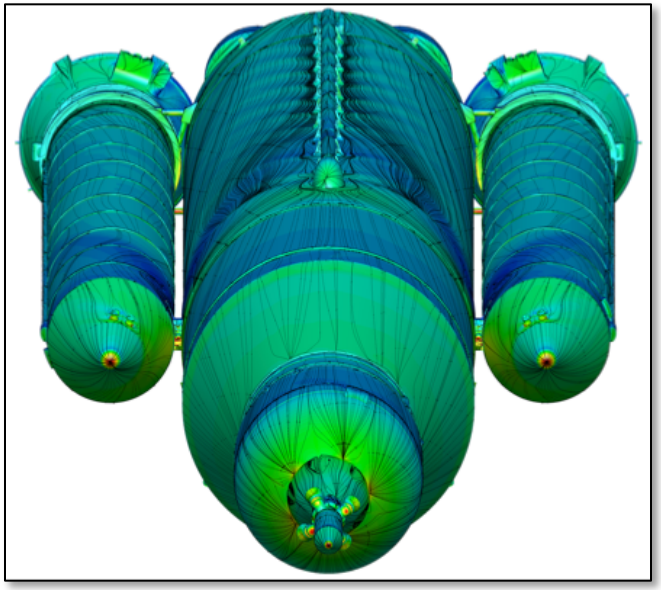
Plot of the radial velocity perturbation of an excited acoustic mode. The simulation encompasses the disk at large radii and the star at small radii. The boundary layer is shown as a thin strip between the strand and the disk that is numerically resolved. The "jump" between the star and disk solutions for the mode occurs at the co-rotation resonance in the boundary layer where the mode is excited.

POC: Mikhail Belyaev, mbelyaev@astro.princeton.edu; Princeton University

CFD Simulations of SLS Ascent Provide Key Aerodynamic Data for SLS DAC3 *

- The Space Launch System (SLS) computational fluid dynamics (CFD) team at NASA Ames performed high-fidelity simulations of ascent aerodynamics for the SLS Design Analysis Cycle 3 (DAC3). Activities include:
  - Simulated 415 cases covering a wide range of Mach numbers and flight angles throughout the launch trajectory.
  - Used the high-fidelity, viscous CFD code OVERFLOW.
- Results will provide SLS teams with a database of critical aerodynamic data, including:
  - Integrated force and moment data.
  - Lineloads along the vehicle.
  - Airload contributions from key protuberances (such as brackets, fuel feedlines).
- These intensive simulations utilized over 10 million processor hours on the Pleiades supercomputer and required over 220 terabytes of storage.

Mission Impact: High-fidelity computational fluid dynamics simulations of SLS ascent provide critical aerodynamic data for trajectory adjustments, structural analyses, and other key studies needed to optimize vehicle safety and performance.



Visualization from an OVERFLOW computational fluid dynamics simulation of the SLS DAC3 design during ascent. Colors show surface pressure coefficients on the vehicle and the black lines show surface streamlines. *Jeff Onufer, NASA/Ames*

POC: Cetin Kiris, cetin.c.kiris@nasa.gov, (650) 604-4485, NASA Advanced Supercomputing Division

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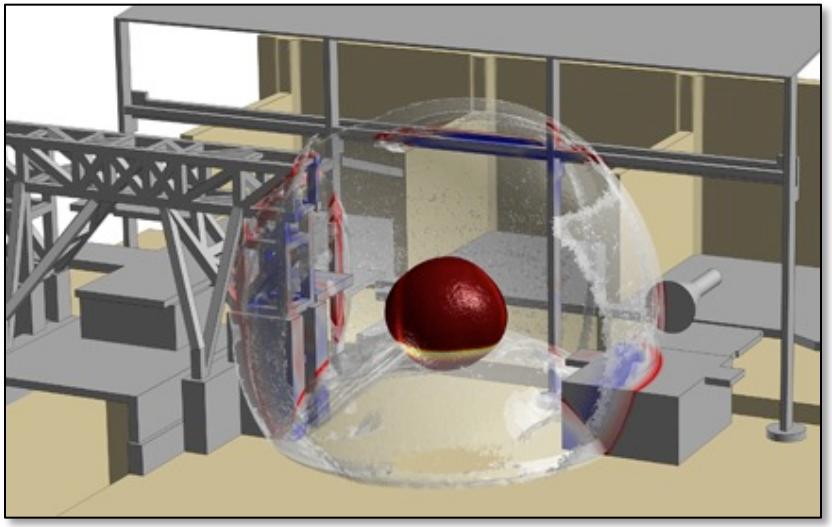
Simulations Run on Pleiades Improve Rocket Blast Risk Prediction Capabilities *

- Aerospace engineers at Marshall Space Flight Center (MSFC) used Pleiades to perform high-fidelity computational fluid dynamics (CFD) simulations of rocket propellant blast environments in the presence of complex structures within engine test facilities.
- Such predictions cannot be sufficiently captured by standard semi-empirical blast models. The MSFC simulations have:
  - Successfully validated results with experimental data for a high-explosive detonation in a NASA engine test facility.
  - Enabled visualization of blast wave evolution and interactions with the surrounding structure to identify regions of interest, providing significant insight into the propagation of blast waves and their interactions with the test facility structure.
- Each simulation was performed on Pleiades using approximately 2,000 processors, and generated over 2 terabytes of data.

Mission Impact: HECC supercomputing resources are vital to NASA engineers who are working to improve the agency's rocket blast prediction capabilities, which will in turn enable them to better define and mitigate inherent risks to vehicles and crew.



Simulated detonation of a high-yield explosive near a rocket test facility. Combustion products are shown as an isosurface colored by temperature. The blast wave is represented by an isosurface of the pressure gradient. The impingement pressure on the facility structures is represented by surface contours, with red for positive gauge pressure and blue for negative gauge pressure.

POC: Brandon Williams, brandon.williams@nasa.gov, (256) 544-3637, Marshall Space Flight Center

** HECC provided supercomputing resources and services in support of this work*

HECC Facility Hosts Several Visitors and Tours in April 2014

- HECC hosted 10 tour groups in April; guests learned about the agency-wide missions being supported by Pleiades and viewed scientific results on the hyperwall system. Visitors this month included:
  - Participants of an Advanced Study Team on National Land Imaging (included staff from JPL, GSFC and the U.S. Geological Survey) were briefed on the NEX project by Jennifer Dungan.
  - Members of the Department of Energy and Department of Defense, including Chief Information Officer Teri Takai, and members of the Singapore Ministry of Defense and the Embassy of Singapore. All were at Ames for a U.S. Command, Control, and Communications Forum, and toured the NAS facility as guests of Pete Worden.
  - Associate Administrator of the Space Technology Mission Directorate, Michael Gazarik; NASA Deputy Chief Information Officer and Acting Chief Technology Officer (CTO), Deborah Diaz; and other personnel, were at Ames for CTO meetings and toured the facility.
  - 25 female high school students from Columbia visited the facility. This group was here to participate in the FIRST (For Inspiration and Recognition of Science and Technology) Robotics Competition tournament at San Jose State University.
  - Tyler Arnold, co-founder and CEO of SimplySocial Inc., was briefed by Rupak Biswas on the QuAIL system.

Bryan Biegel, deputy chief of the NASA Advanced Supercomputing Division, presented some of the agency's science and engineering projects on the hyperwall to Columbian high school students participating in a local robotics competition.

POC: Gina Morello, gina.f.morello@nasa.gov, (650) 604-4462, NASA Advanced Supercomputing Division

Papers and Presentations

- "**Validating a Time-Dependent Turbulence-Driven Model of the Solar Wind**," R. Lionello, M. Velli, C. Downs, J. A. Linker, A. Miki, A. Verdini, The Astrophysical Journal, vol. 784, no. 2, April 1, 2014. * *http://iopscience.iop.org/0004-637X/784/2/120/pdf/0004-637X_784_2_120.pdf*
- "**On the Signatures of Magnetic Islands and Multiple X-lines in the Solar Wind as Observed by ARTEMIS and WIND**," S. Eriksson, D. L. Newman, G. Lapenta, V. Angelopoulos, Plasma Physics and Controlled Fusion, vol. 56, no. 6, April 1, 2014. * *http://iopscience.iop.org/0741-3335/56/6/064008*
- **"Tensor-Product Preconditioners for a Space-Time Discontinuous Galerkin Method,"** L. T. Diasady, S. M. Murman, presented at the 10th International Conference of Computational Methods in Sciences and Engineering, Athens, Greece, April 4-7, 2014. *
- "**An Efficient, Multi-layered Crown Delineation Algorithm for Mapping Individual Tree Structure Across Multiple Ecosystems**," L. I. Duncanson, B. D. Cook, G. C. Hurtt, R. O. Dubayah, Remote Sensing Environment (Ahead of Print), April 6, 2014. * *http://www.sciencedirect.com/science/article/pii/S0034425714000984*
- "**WACCM-X Simulation of Tidal and Planetary Wave Variability in the Upper Atmosphere**," H.-L. Liu, Modeling the Ionosphere-Thermosphere, pp. 181-195, April 7, 2014 (print). * *http://onlinelibrary.wiley.com/doi/10.1002/9781118704417.ch16/summary*

** HECC provided supercomputing resources and services in support of this work*

Papers and Presentations (continued)

- "**Validating Time-Distance Helioseismology with Realistic Quiet Sun Simulations**," K. DeGrave, J. Jackiewicz, M. Rempel, arXiv:1404.4645 [astro-ph.SR], April 17, 2014. * *http://arxiv.org/abs/1404.4645*
- "**Too Big to Fail in the Local Group**," S. Garrison-Kimmel, M. Boylan-Kolchin, J. S. Bullock, E. N. Kirby, arXiv:1404.5313 [astro-ph.GA], April 21, 2014. * *http://arxiv.org/abs/1404.5313*
- "**Electromagnetic Energy Conversion in Downstream Fronts from Three Dimensional Kinetic Reconnection**," G. Lapenta, M. Goldman, D. Newman, S. Markidis, A. Divin, Physics of Plasmas, vol. 21, issue 5, April 23, 2014. * *http://scitation.aip.org/content/aip/journal/pop/21/5/10.1063/1.4872028*
- **2014 SGI User Group Conference**, San Jose, CA, April 29–May 1, 2014
  - "**Advanced Computing: Supporting Science at NASA**," Piyush Mehrotra (keynote presentation).
  - "**Using System Log Files to Characterize Batch Job Failures**," David Barker. *http://www.sgiug.org/2014abstracts/system_log_files_abstract.html*
  - "**Evaluation of an Intel Xeon Phi Based Computing System**," Henry Jin. *http://www.sgiug.org/2014abstracts/xeon_phi_abstract.html*
- "**Propeller-driven Outflows from an MRI Disc**," P. S. Lii, M. M. Romanova, G. V. Ustyugova, A. V. Koldoba, R. E. Lovelace, Monthly Notices of the Royal Astronomical Society, vol. 440, issue 1 (Early Release), April 2014. * *http://mnras.oxfordjournals.org/content/441/1/86.full*

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Papers and Presentations (continued)

- "**Supersonic Retropropulsion Computational-Fluid-Dynamics Validation with Ames 9x7 Foot Test Data**," D. G. Schauerhamer, K. A. Zarchi, W. L. Kleb, K. T. Edquist, Journal of Spacecraft and Rockets (Ahead of Print), April 2014. * *http://arc.aiaa.org/doi/abs/10.2514/1.A32694*
- "**Hot Carbon Corona in Mars' Upper Thermosphere and Exosphere: 1. Mechanisms and Structure of the Hot Corona for Low Solar Activity at Equinox**," Y. Lee, M. R. Combi, V. Tenishev, S. W. Bougher, Journal of Geophysical Research: Planets (Accepted Article), April 2014. * *http://onlinelibrary.wiley.com/doi/10.1002/2013JE004552/abstract*

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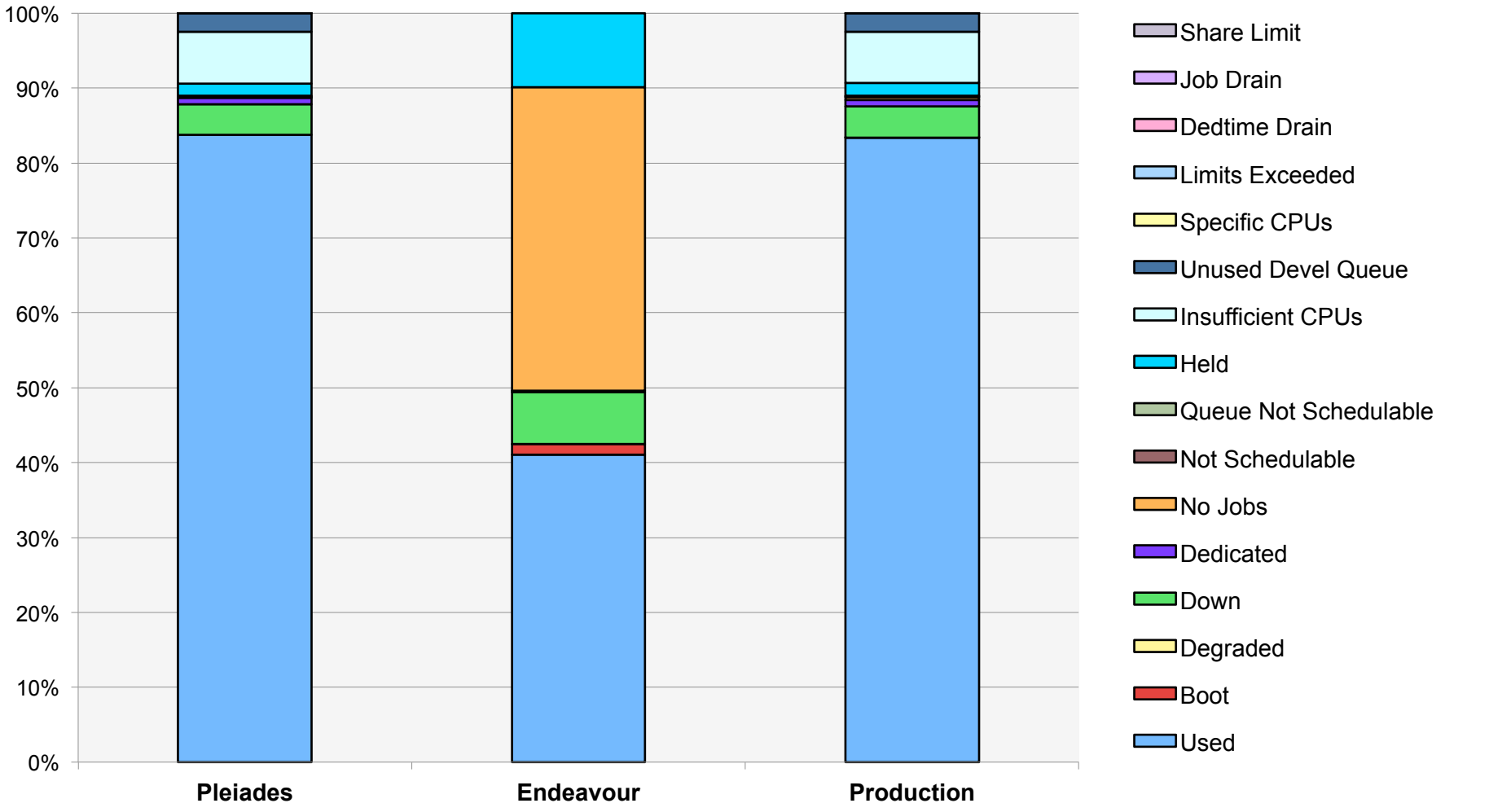
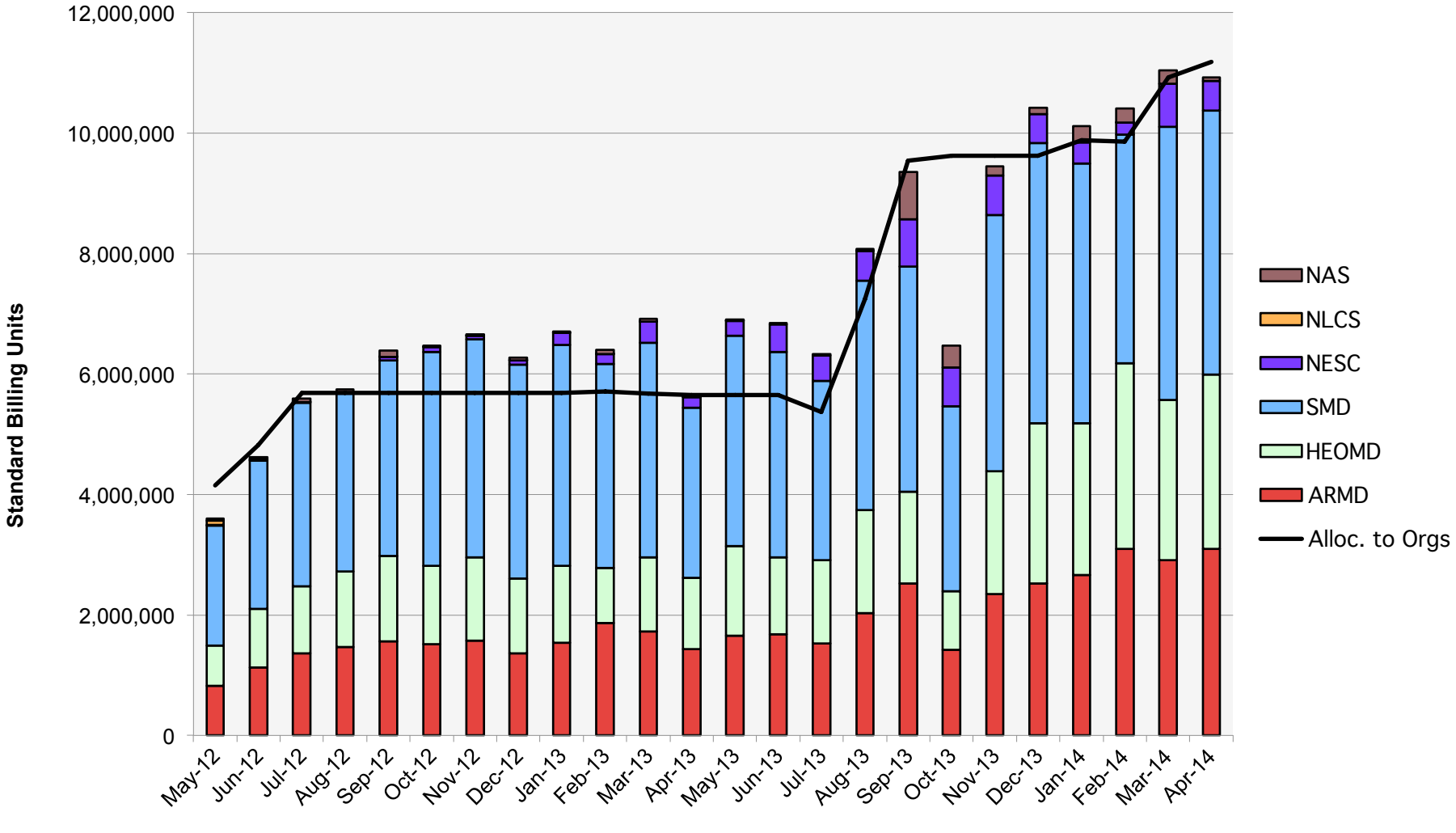
News and Events

- **How NASA is Meeting the Big Data Challenge**, *HPCwire*, April 7, 2014—In a technical paper published online, Piyush Mehrotra and Harper Pryor of the NAS Division report on how the agency is tackling the issues of Big Data: access, transportation, management, and dissemination.
  http://www.hpcwire.com/2014/04/07/nasa-meeting-big-data-challenge
- **NASA's Rupak Biswas Sees Usable Quantum Computing Before End of Decade**, *Scientific Computing*, April 17, 2014—In an interview with Scientific Computing staff, Rupak Biswas describes some of the early applications that NASA is exploring on the D-Wave machine and touches on the agency's plans for exascale computing.
  http://www.scientificcomputing.com/articles/2014/04/nasa%E2%80%99s-rupak-biswas-sees-usable-quantum-computing-end-decade
- **Big Data and the History of Information Storage**, *WinShuttle*, April 2014—In a detailed timeline of the history of Big Data, NAS researchers Michael Cox and David Ellsworth are credited as coining the term "big data" in a 1997 NAS technical report.
  http://www.winshuttle.com/big-data-timeline/
- **Why Earth Matters to NASA: A Conversation with Harrison Ford**, *NASA*, April 22, 2014—Actor Harrison Ford visited the NAS facility to film a segment of the Showtime documentary "Years of Living Dangerously" and talked with NEX scientist Rama Nemani about the agency's Earth science research and the goal to share data with the global community.
  http://www.nasa.gov/content/why-earth-matters-to-nasa-a-conversation-with-harrison-ford

HECC Utilization



HECC Utilization Normalized to 30-Day Month



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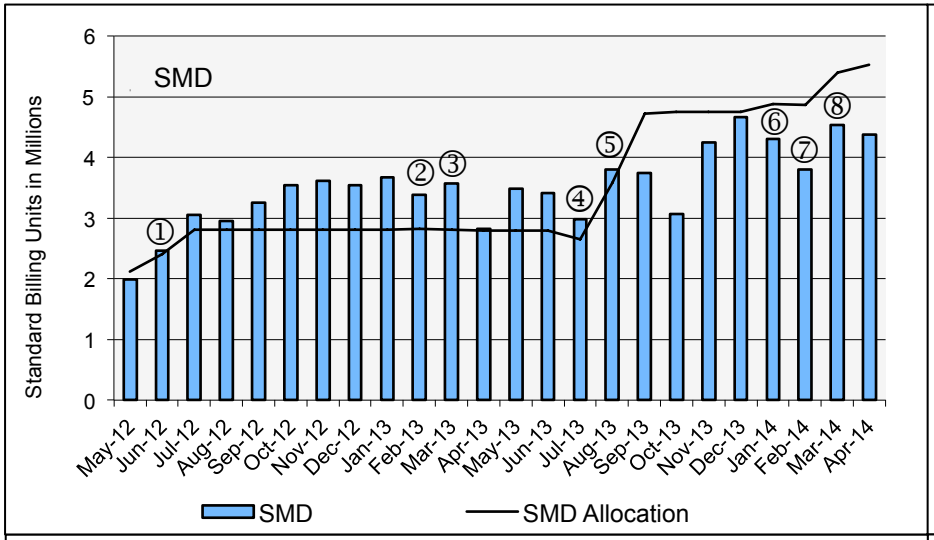
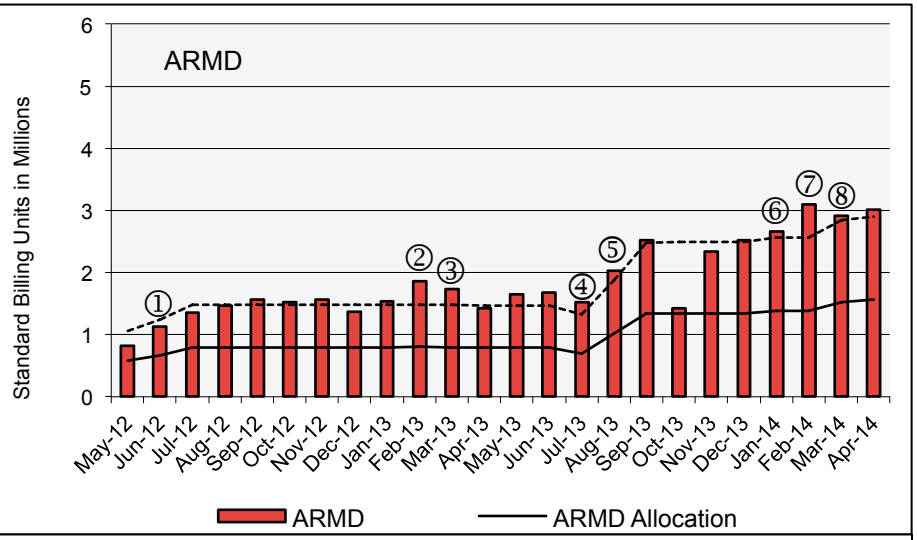
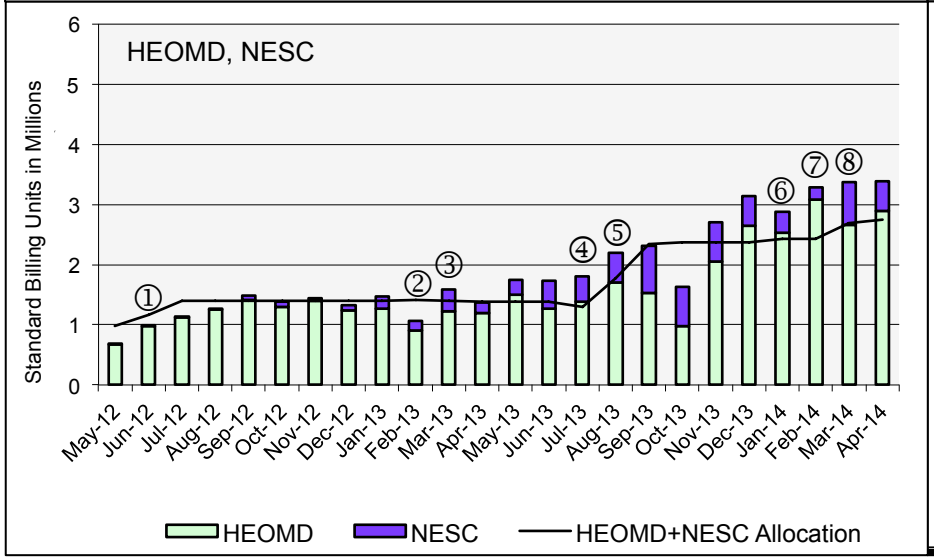






① 24 Sandy Bridge Racks added

② Columbia 21, 23, and 24 retired, Endeavour 2 added

③ Columbia 22 retired; Endeavour 1 added

④ 32 Harpertown Racks retired

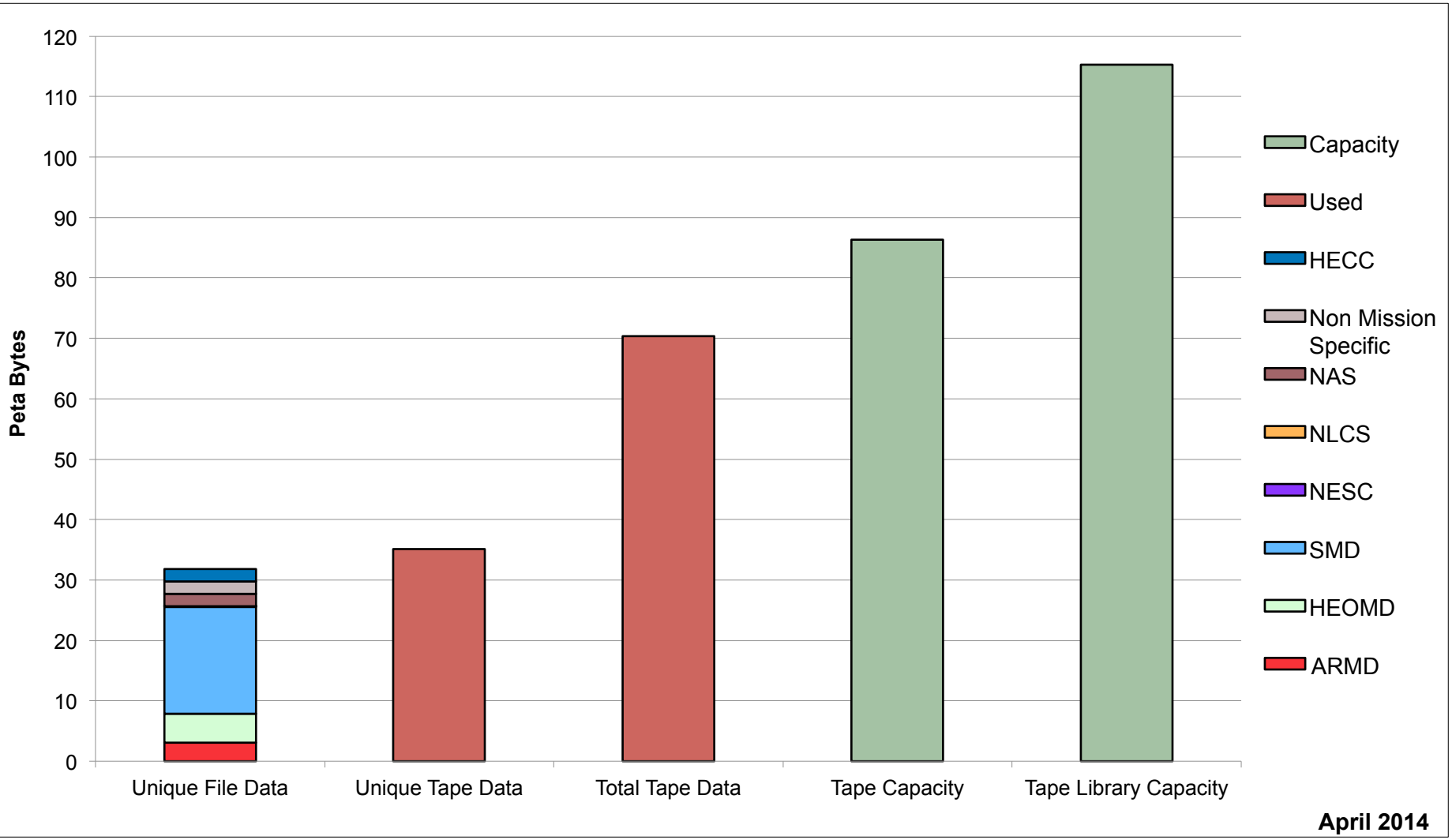
⑤ 32 Harpertown Racks retired; 46 Ivy Bridge Racks added

⑥ 6 Ivy Bridge Racks added; 20 Nehalem and 12 Westmere Racks Retired

⑦ 8 Ivy Bridge Racks added mid-Feb; 8 additional Ivy Bridge Racks late Feb.

⑧ 4 Ivy Bridge Racks added mid-March

Tape Archive Status



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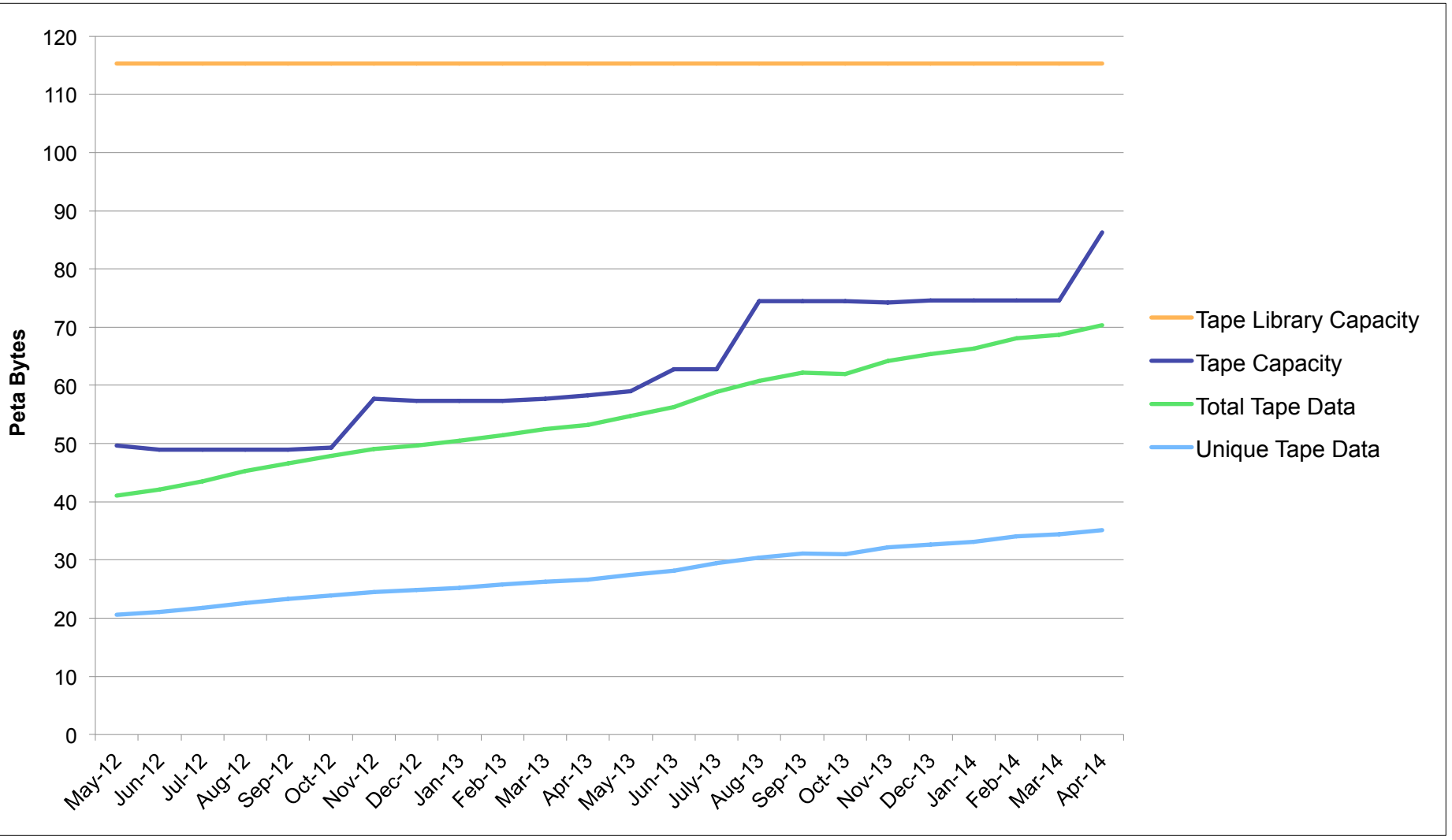
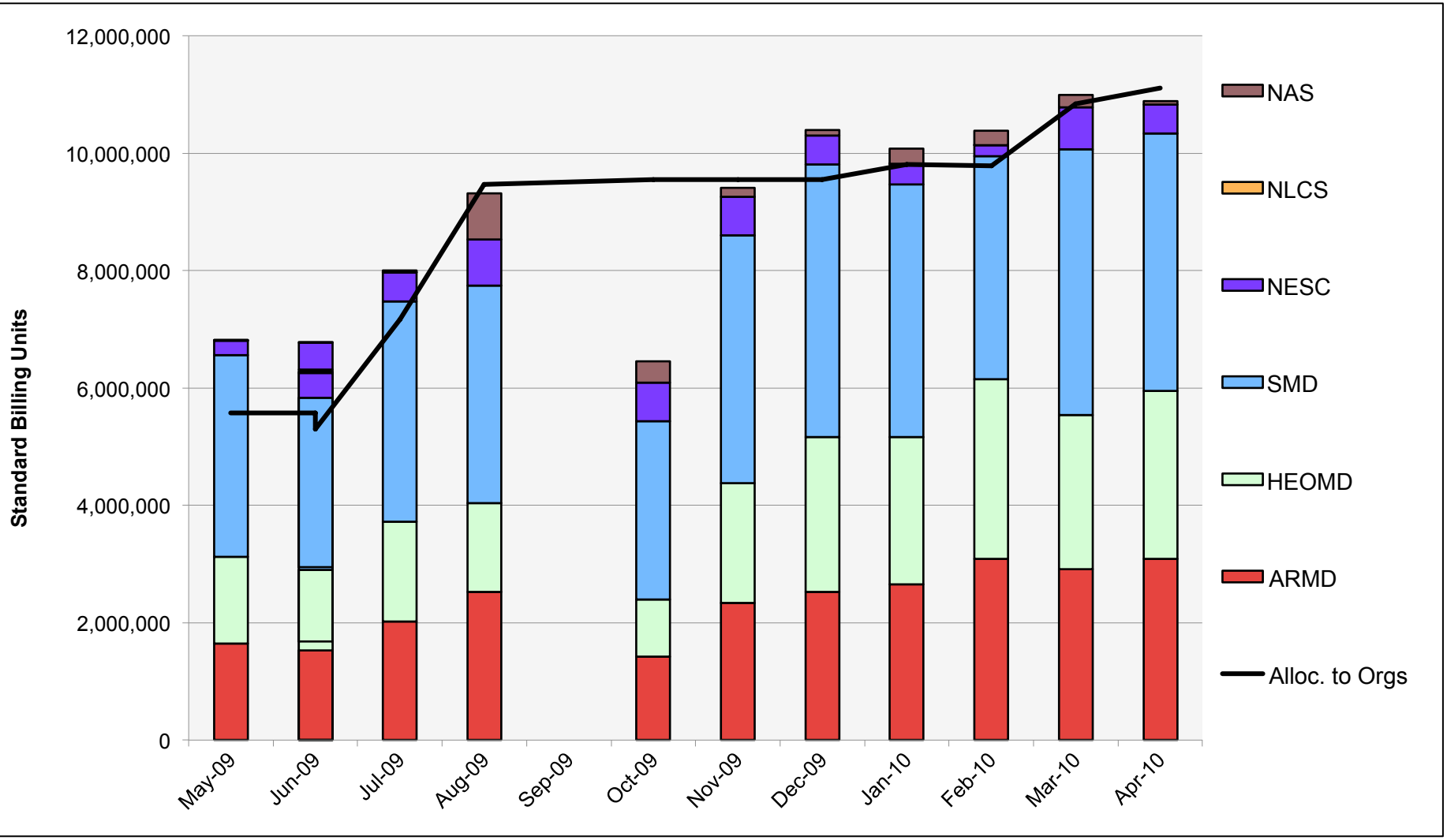
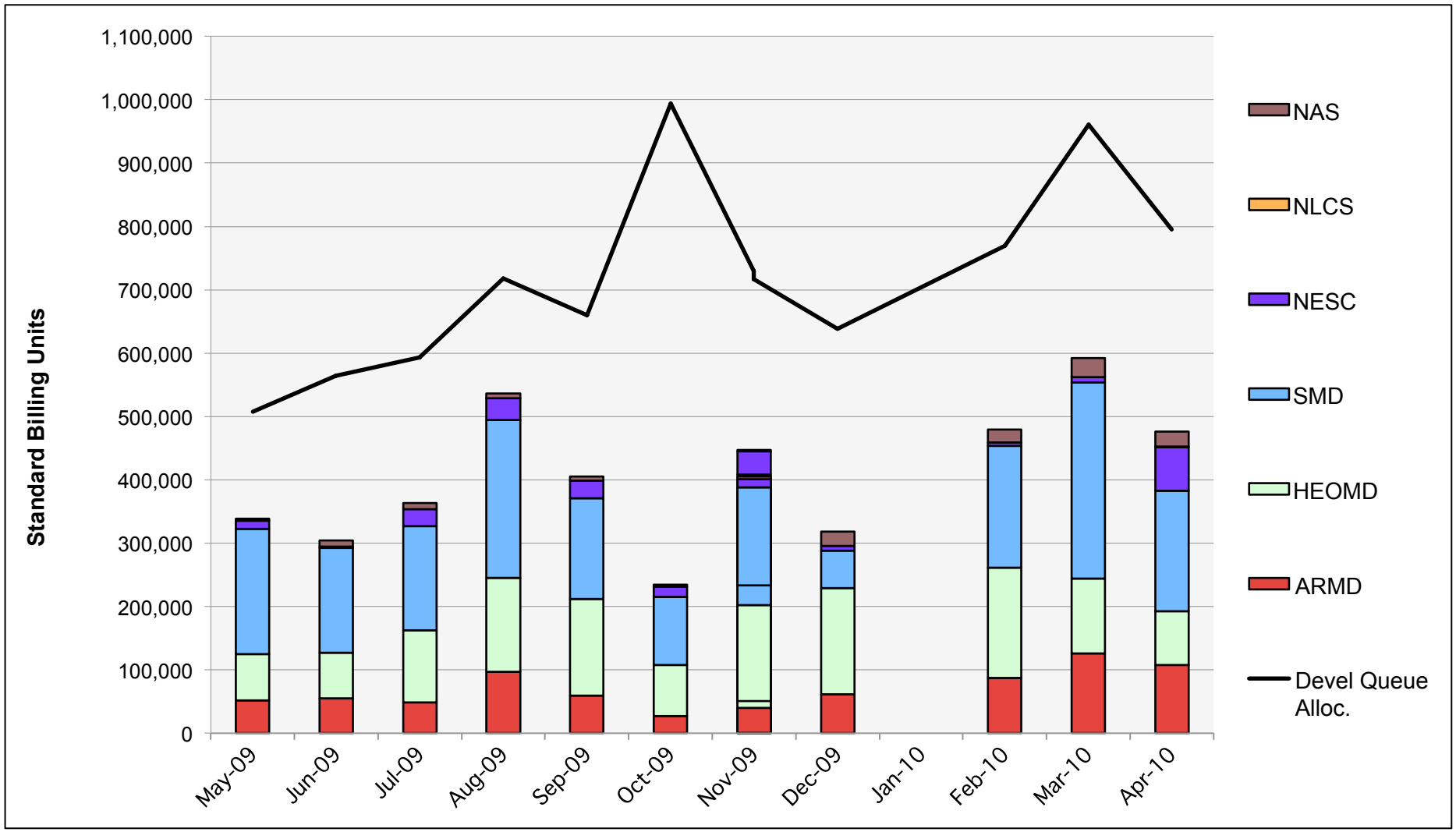


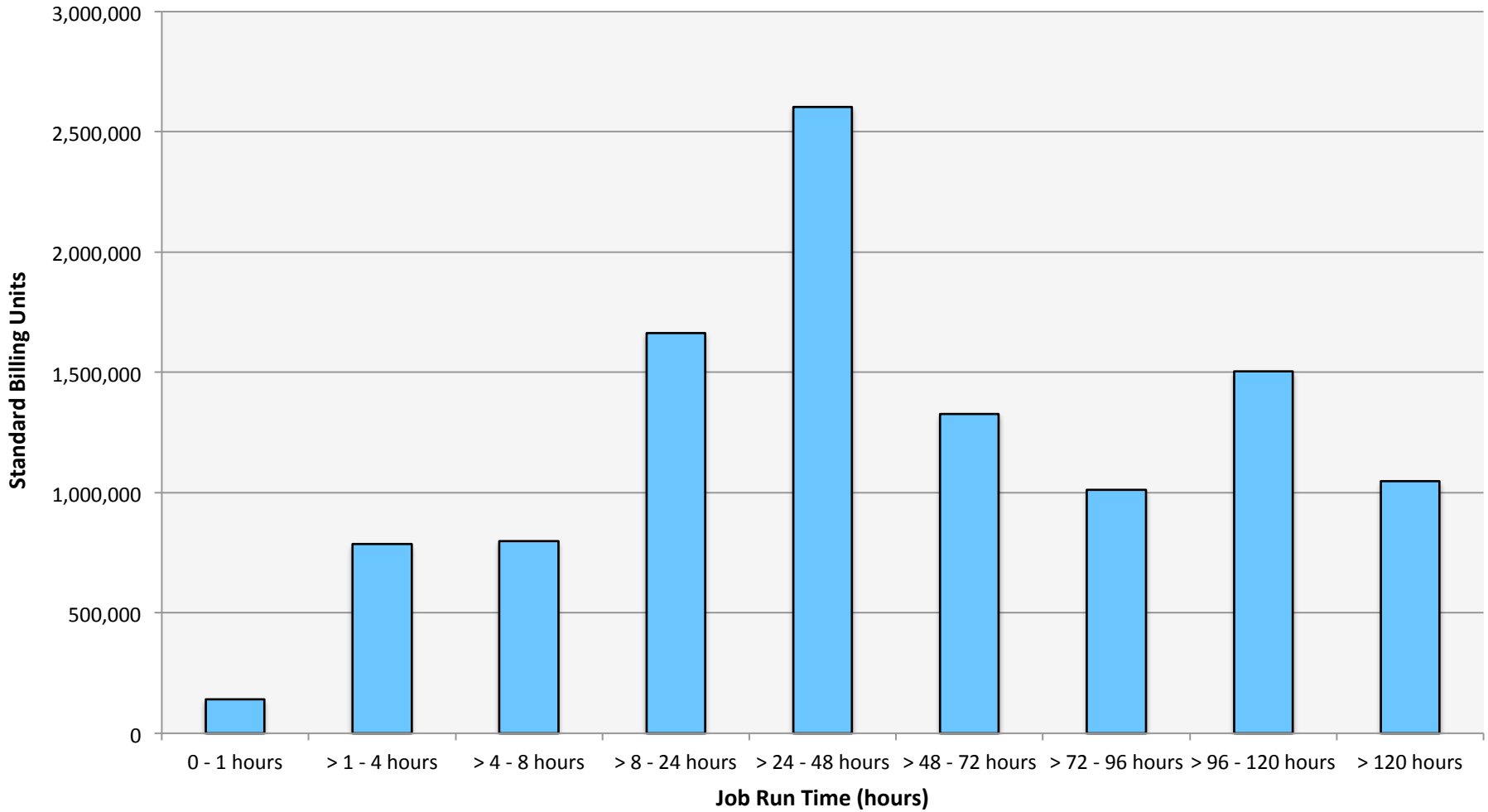
Pleiades:
SBUs Reported, Normalized to 30-Day Month



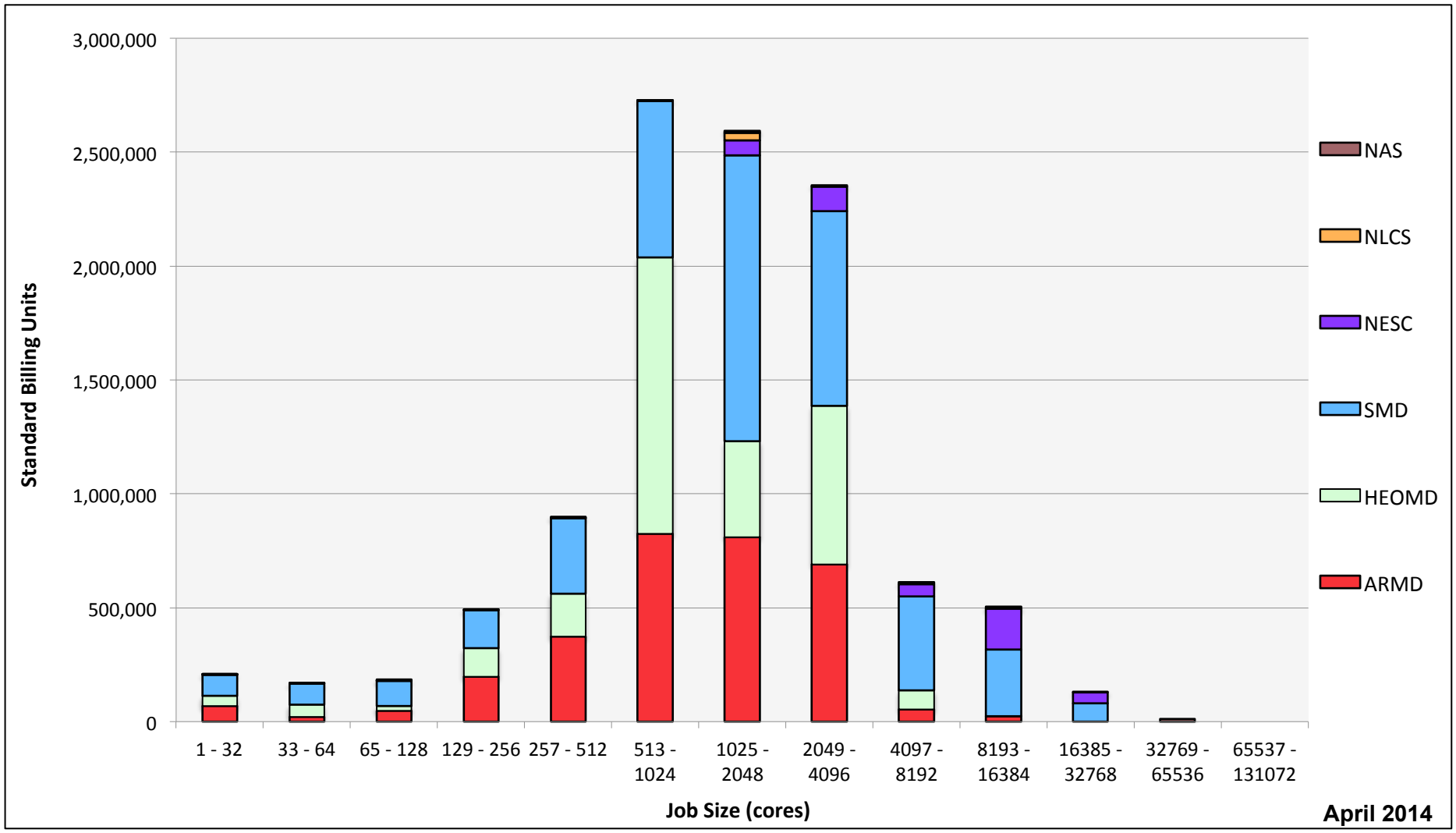
Pleiades:
Devel Queue Utilization



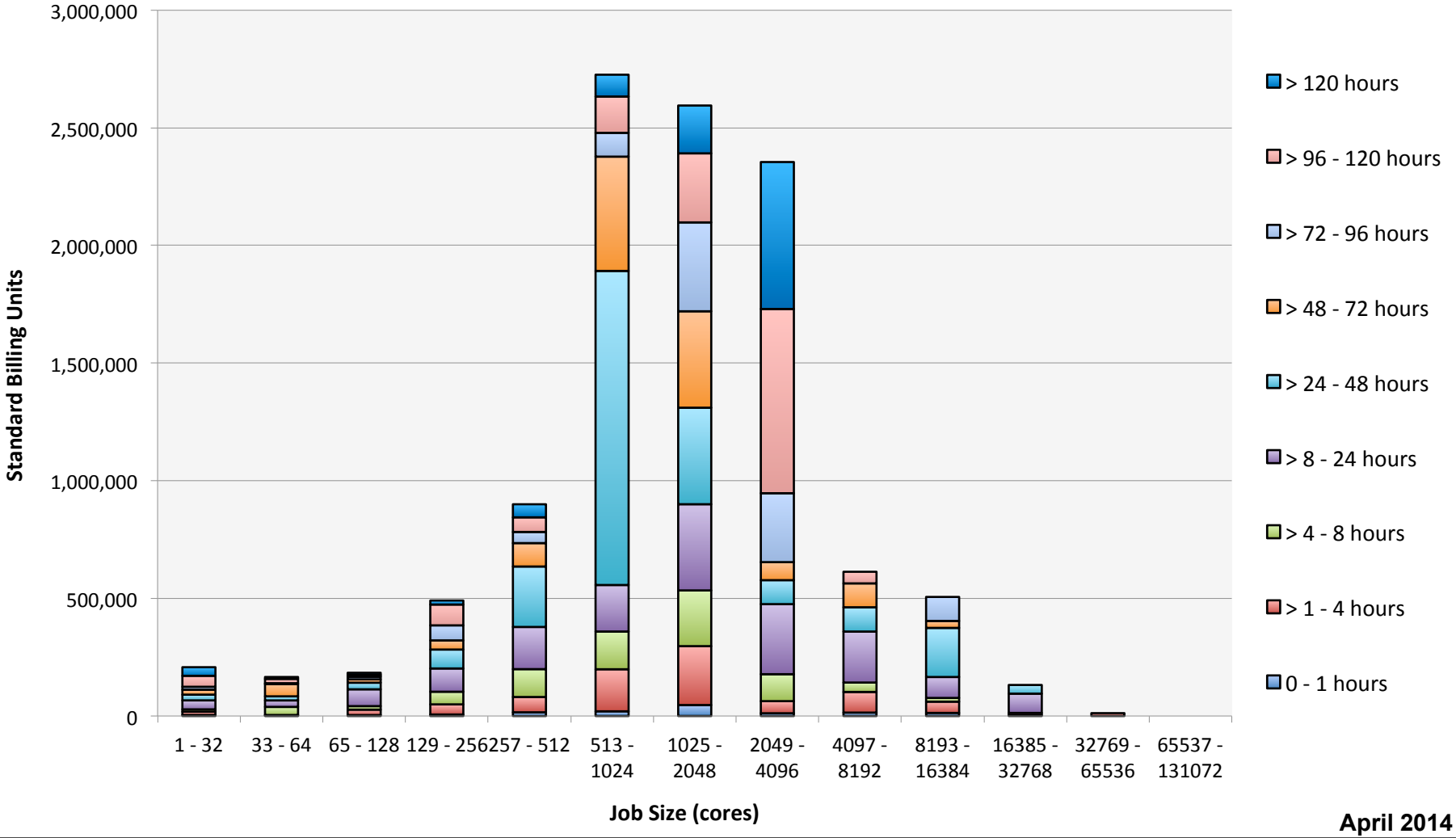
Pleiades:
Monthly Utilization by Job Length



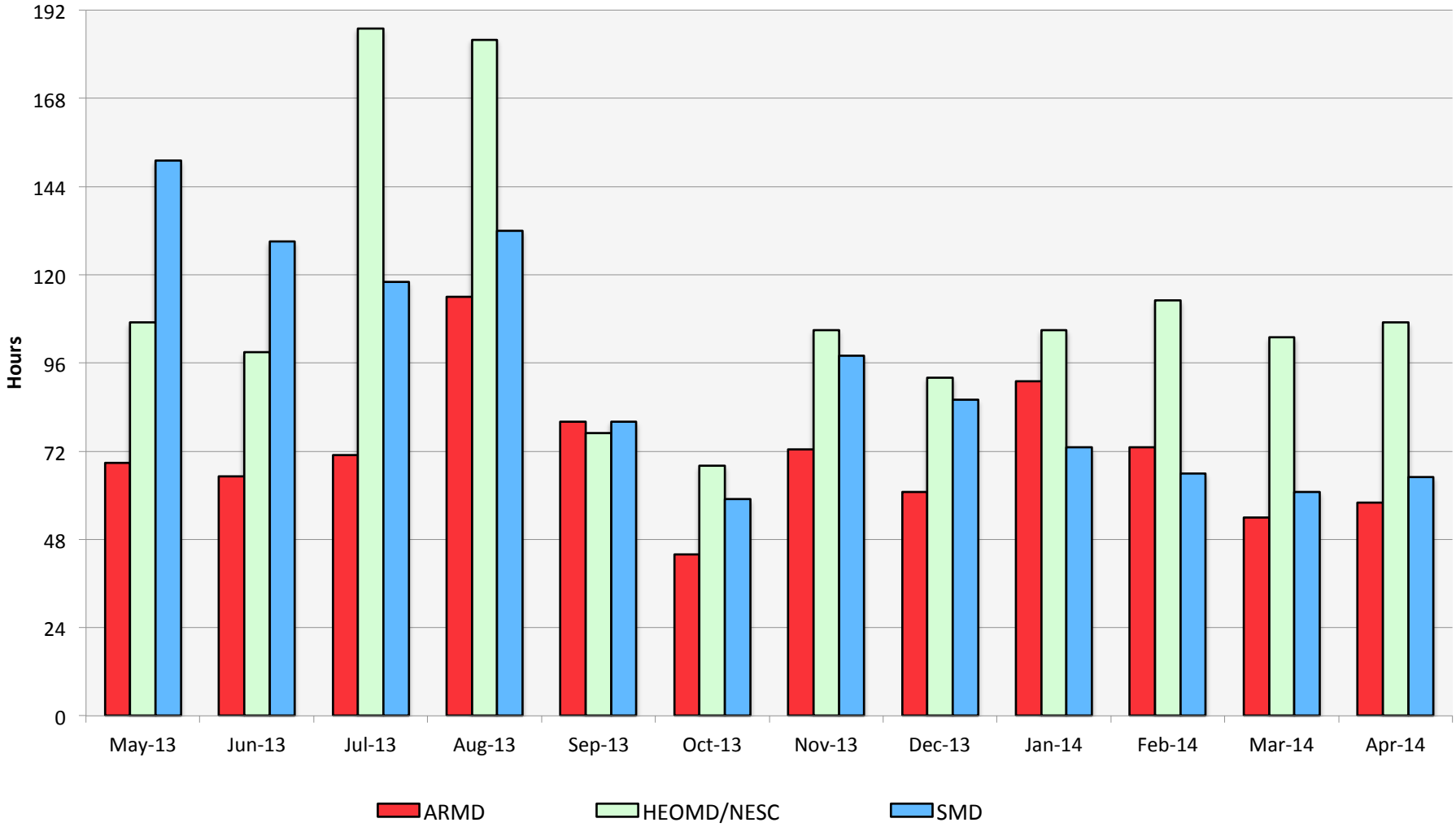
Pleiades:
Monthly Utilization by Size and Mission



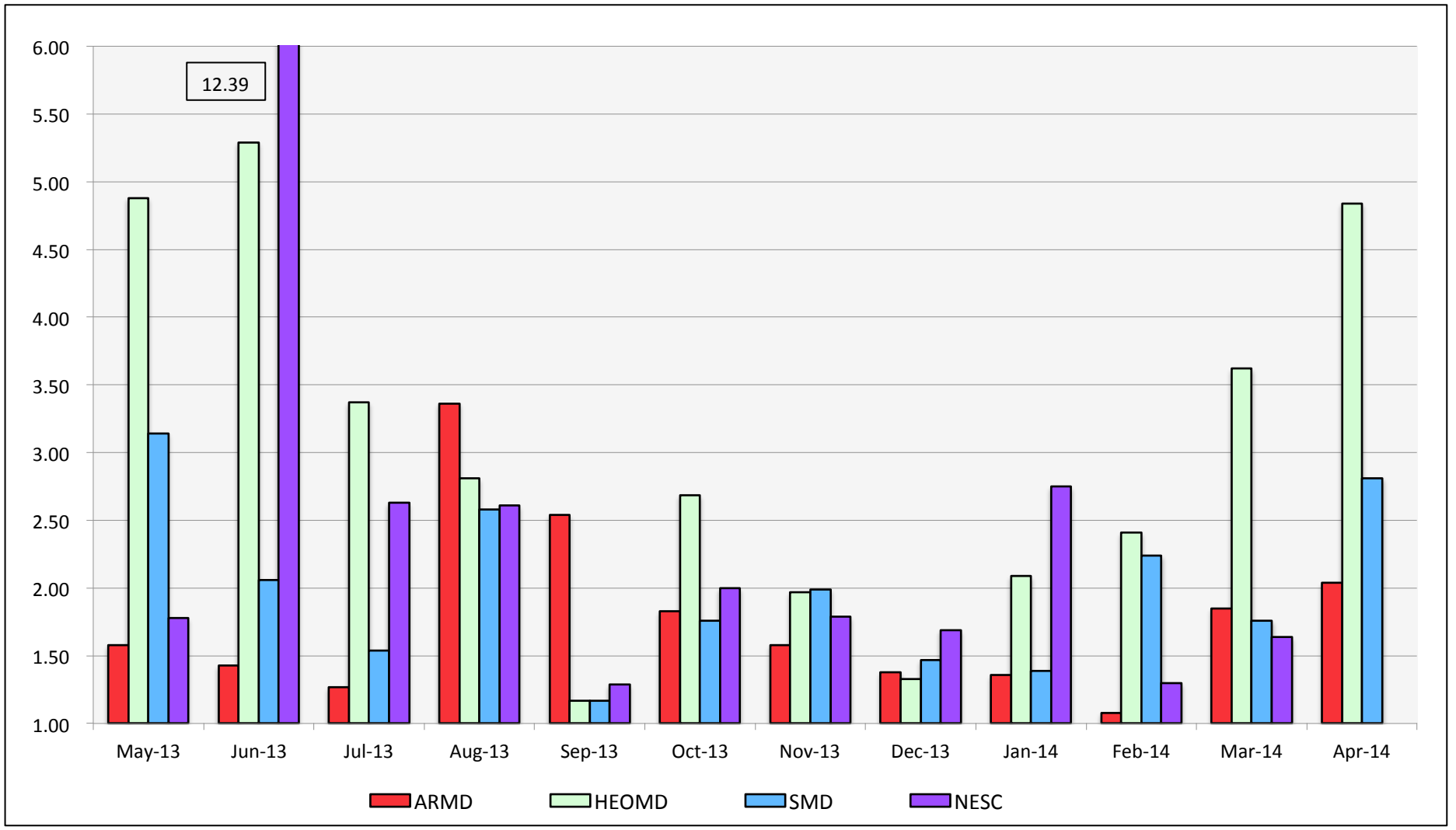
Pleiades:
Monthly Utilization by Size and Length



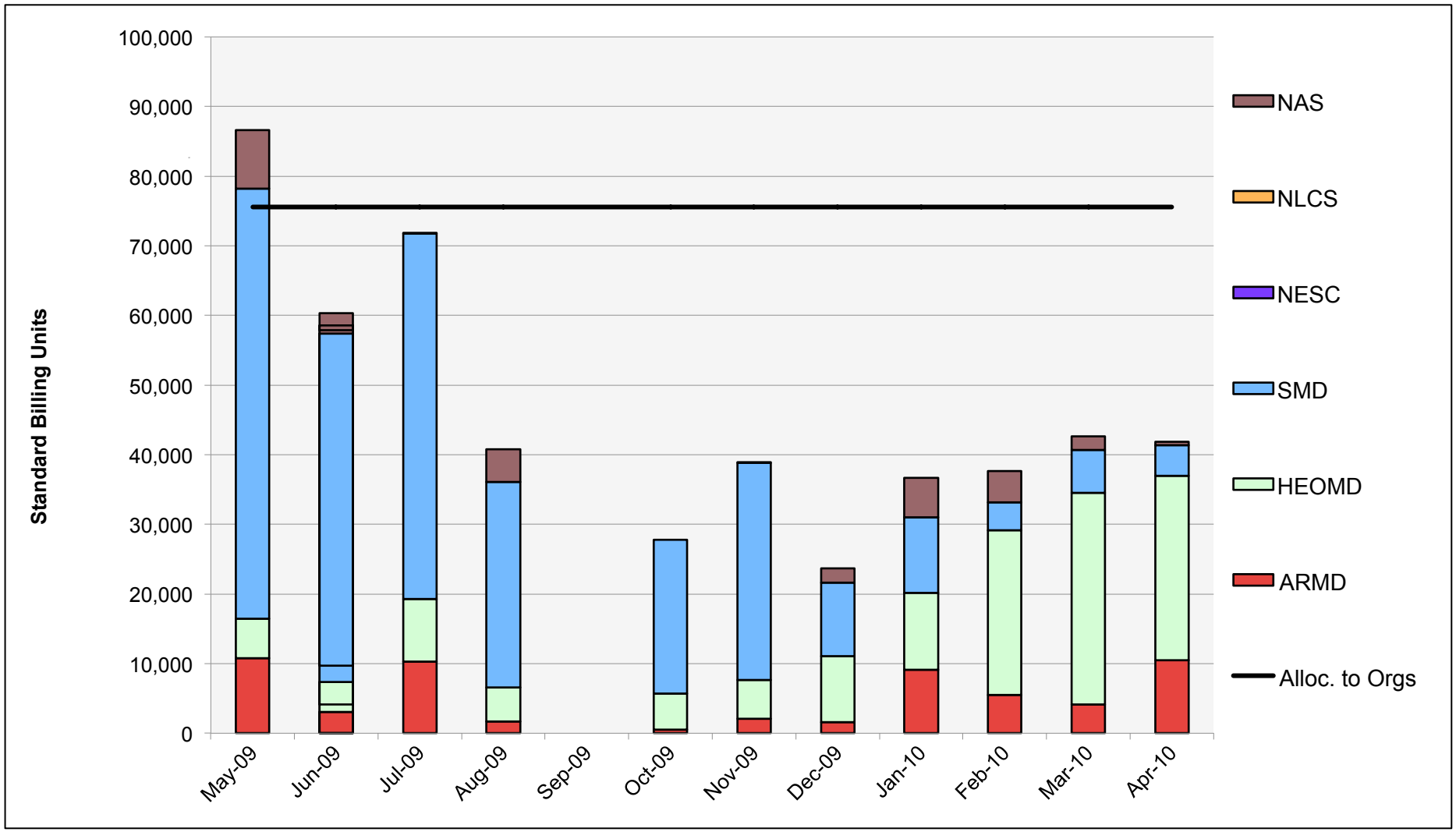
Pleiades:
Average Time to Clear All Jobs



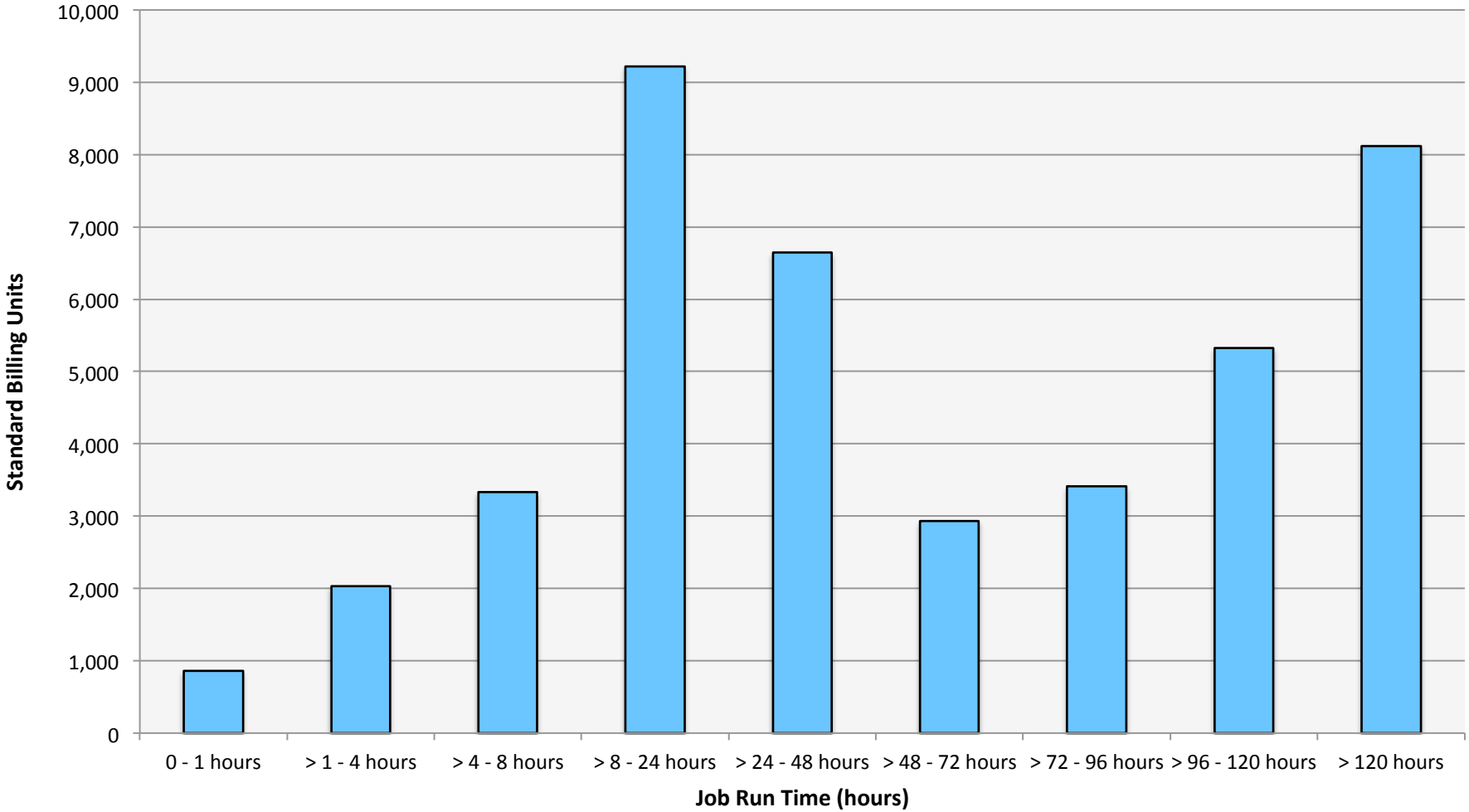
Pleiades:
Average Expansion Factor



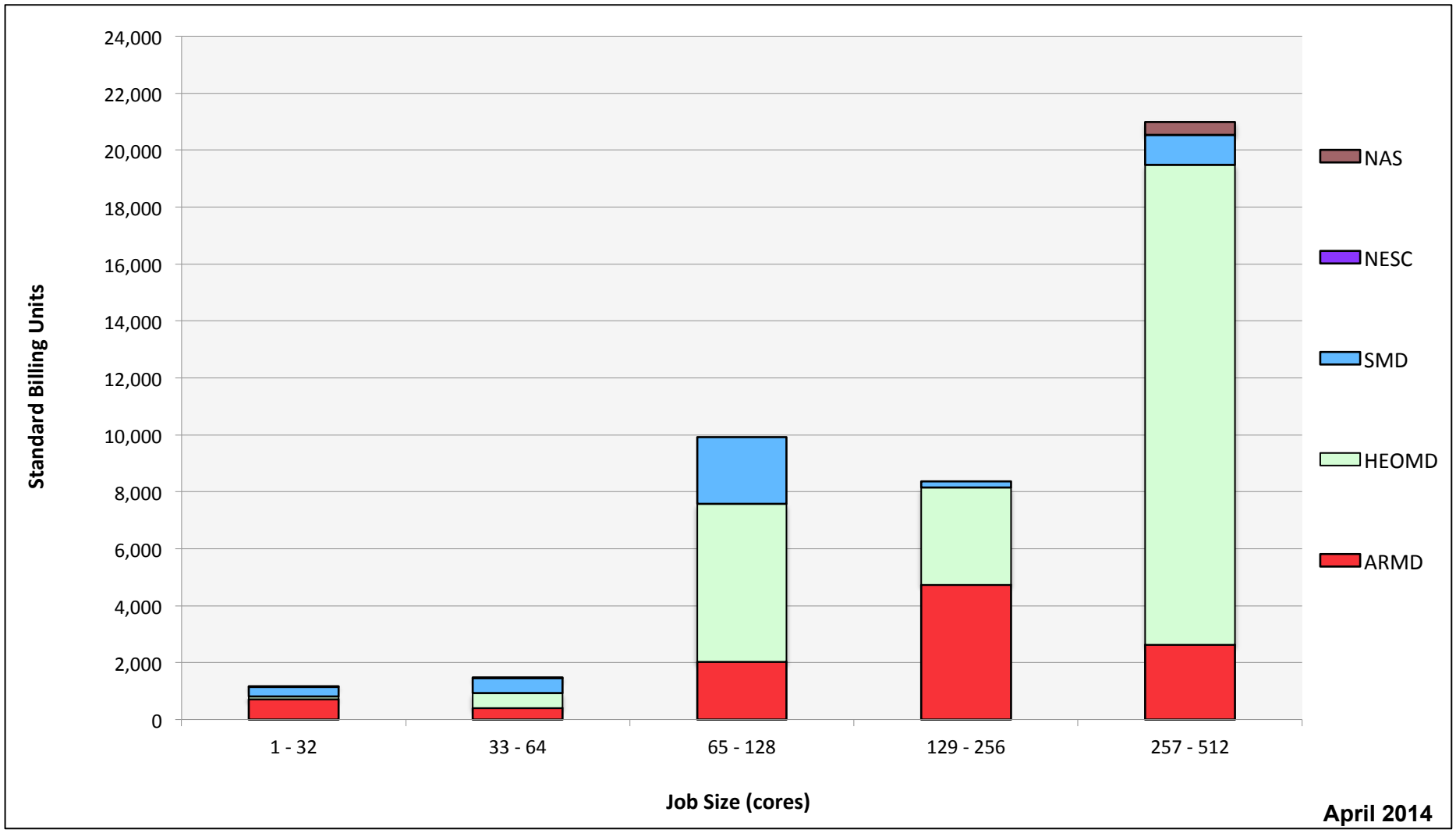
Endeavour:
SBUs Reported, Normalized to 30-Day Month



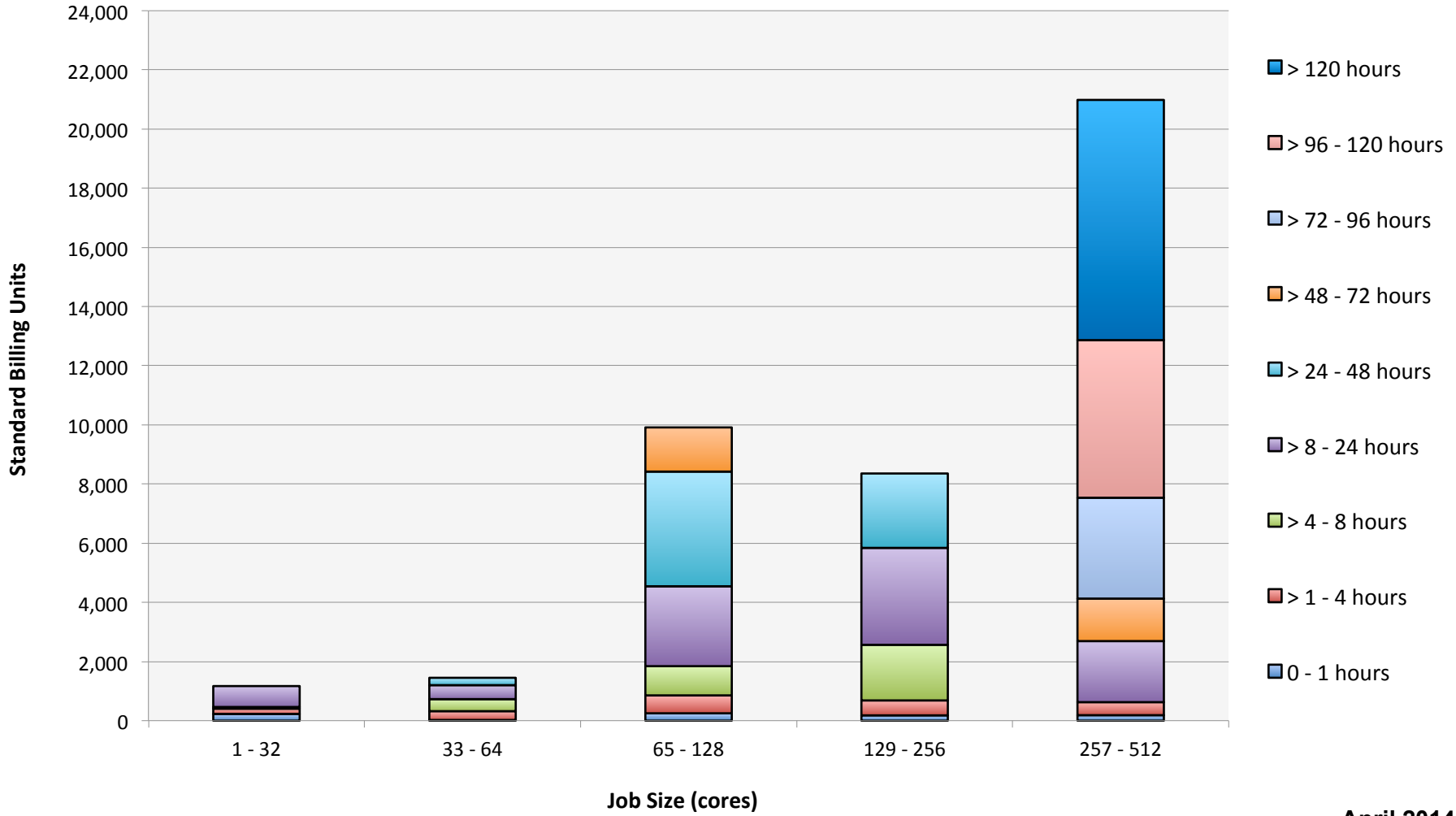
Endeavour:
Monthly Utilization by Job Length



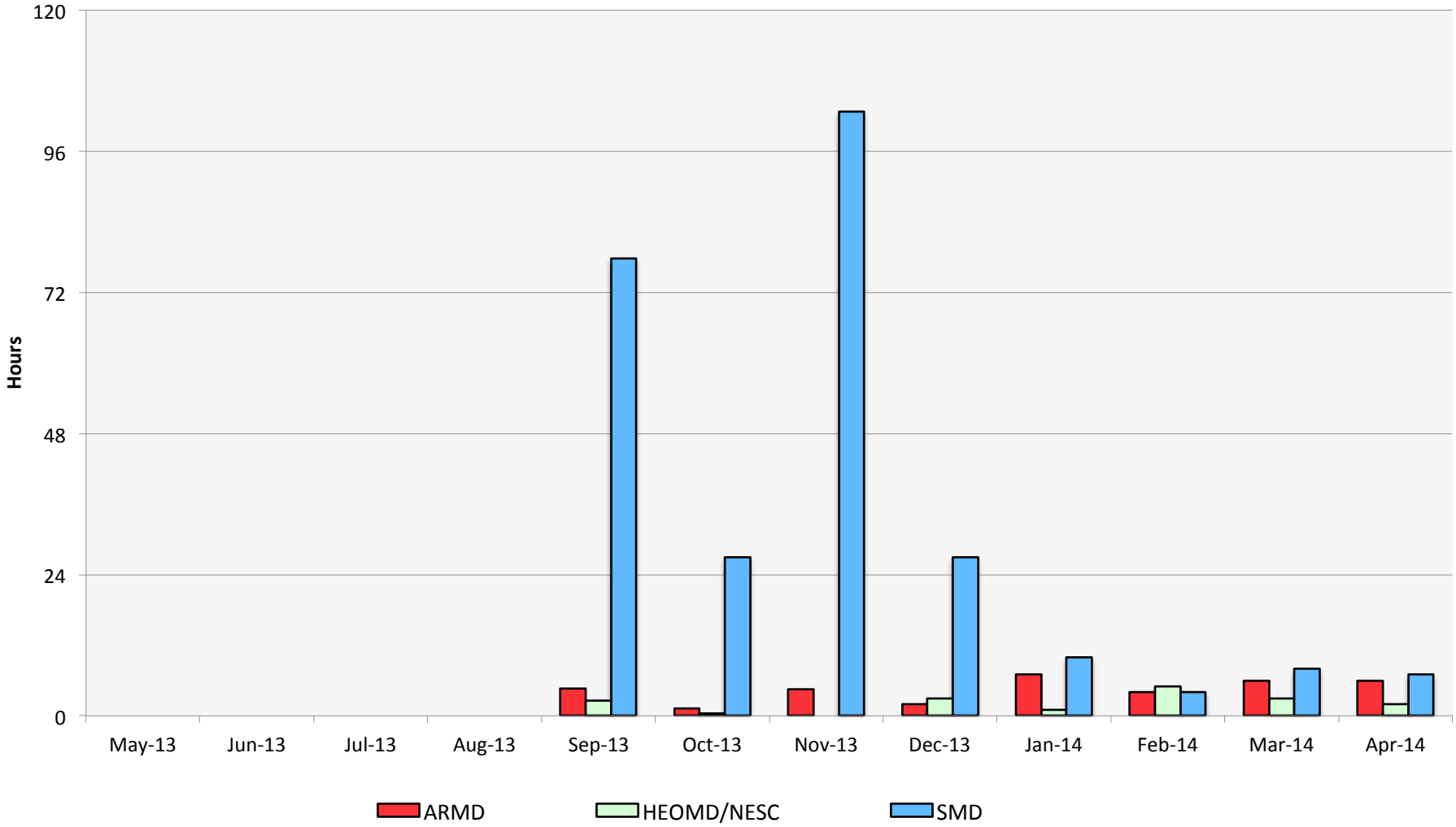
Endeavour:
Monthly Utilization by Size and Mission



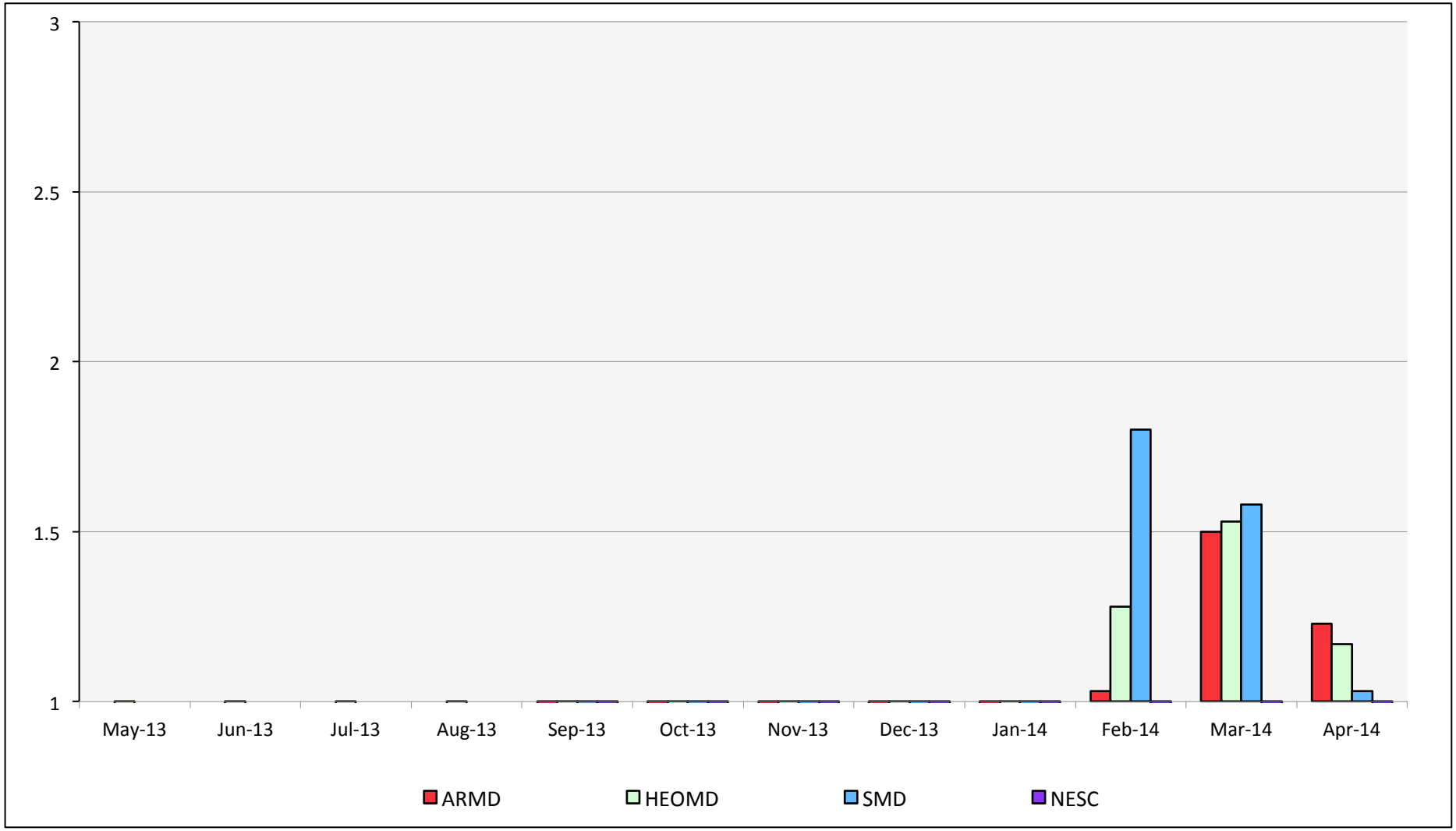
Endeavour:
Monthly Utilization by Size and Length



Endeavour:
Average Time to Clear All Jobs



Endeavour:
Average Expansion Factor



Maia:
SBUs Reported, Normalized to 30-Day Month